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FOR GODDARD SPACE FLIGHT CENTER SPECTROMETER
WATER COLOR STUDY: MISSISSIPPI SOUND AREA,
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WATER MEASUREMENT SUPPORT FOR GODDARD SPACE
FLIGHT CENTER SPECTROMETER WATER COLOR STUDY
MISSISSIPPI SOUND AREA
JULY 24, 1972

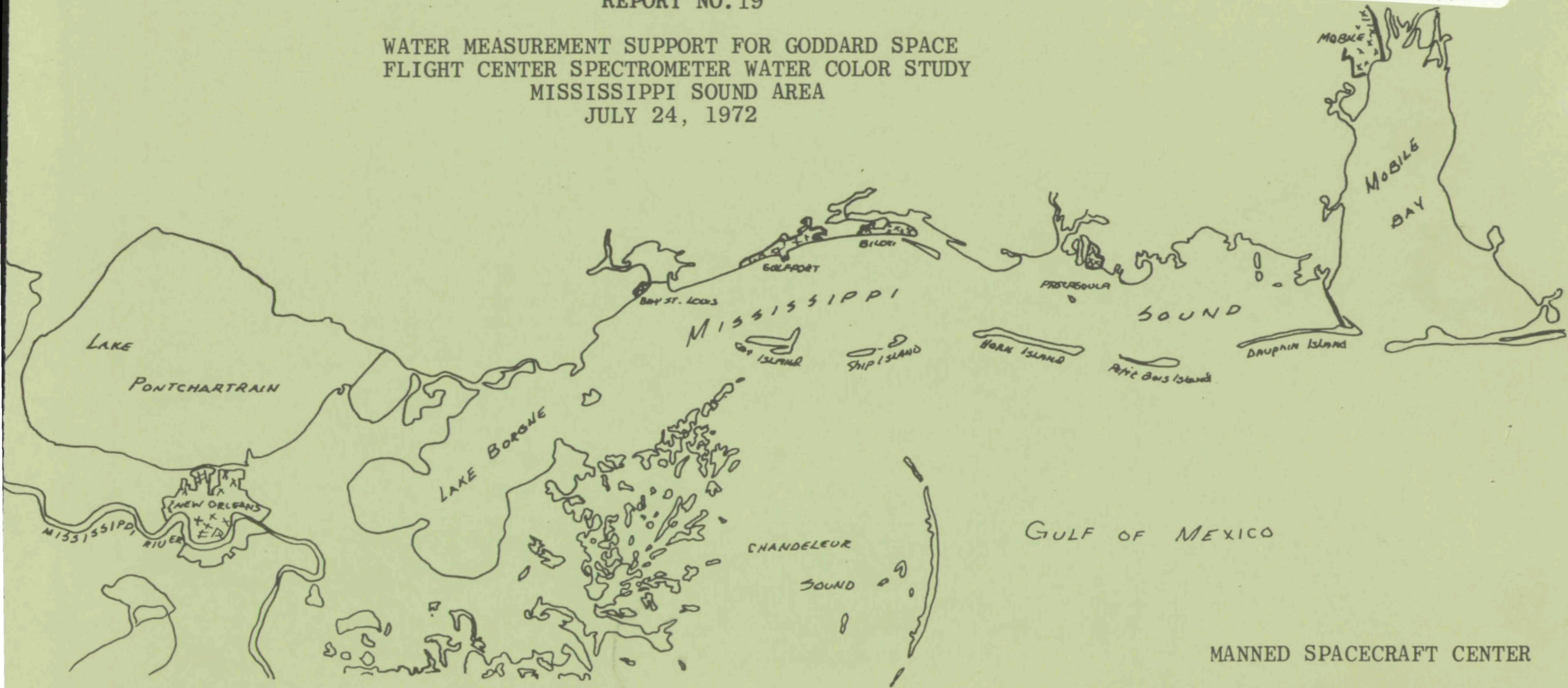


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INTRODUCTION

Dr. William Nordberg, Goddard Space Flight Center (GSFC) requested the Earth Resources Laboratory (ERL) at the Mississippi Test Facility to gather water measurements from surface boats to support a spectrometer water color study being conducted by GSFC personnel. The boat measurements were collected in conjunction with overflights of the Ames CV-990 which is the carrier plane for the spectrometric equipment.

ERL took advantage of boat operations to conduct several light aircraft tests in support of its continuing chlorophyll/turbidity studies in the Mississippi Sound.

The information presented in this report is the surface data collected in support of this mission.

The surface measurements were made and water samples collected by ERL/LEC personnel. The salinity analysis was performed by personnel of the General Electric Company under contract to the Mississippi Test Facility. The chlorophyll analysis was performed by ERL/LEC personnel.

This report was prepared by Mr. James W. Weldon of the NASA Earth Resources Laboratory. Messrs. Jerry Brashier, James Halbach and James Coffren of Lockheed Electronics Company participated in the compilation of the data in this report.

SUMMARY

The NASA Earth Resources Laboratory/Goddard Space Flight Center water study was conducted as originally planned except that the ERL aircraft flew approximately one hour and a half after the CV-990.

Data was collected at all 24 stations with two sets of measurements being taken at different times at all stations except stations A6, B6, C6 and D6.

The sky was clear of clouds; however, considerable haze and smoke were in the area.

The Secchi visibility varied from 3.5 to 12 feet with area B4 to C3 having in general the highest water transparency.

The salinity varied from 21.701 to 29.332 parts/thousand with the west end of the Sound having the lowest salinity.

The chlorophyll A concentration ranged from 0.2 to 4.4 milligrams/cubic meter with one measurement of 8.7 milligrams/cubic meter obtained from station D5. The east end of the Sound had the highest average reading.

The water temperature during the mission ranged from 28.4 to 30.5 degrees C. A maximum variation of 1.6 degrees C took place at station C1 during a four hour and 40 minute period between measurements. This variation is consistent with variations at stations A1, B1 and D1 over a comparable time period and is primarily the result of solar heating. Estimated temperature measurement accuracy is $\pm 0.1^{\circ}\text{C}$.

The typical water depth in the Sound is approximately 12 feet. Several of the measurement stations are near navigation channels such as the Intercoastal Waterway. Because of the one fourth mile estimated positioning accuracy of the boats some large variations in water depth occurred when returning to the same station.

MEASUREMENT SUMMARY CHART

Station	Secchi Visibility Ft.				Salinity Pts/K				Chlorophyll m/m ³				Water Temp Deg C				Water Depth Ft.			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
1	3.5	4.0	10.0	4.0	22.104	27.582	27.462	26.476	2.9	3.0	1.0	3.9	28.8	28.4	28.9	29.0	6	16	15	14
1	4.0	6.0	8.0	6.5	22.282	28.682	27.977	26.237	1.5	2.1	2.9	3.2	30.2	29.5	30.5	30.5	7	16	15	12
2	4.5	6.0	8.0	6.0	21.962	27.136	27.738	28.487	2.5	-	1.6	1.7	29.0	28.3	29.0	29.0	7	16	13	15
2	4.0	6.5	8.0	6.0	21.701	26.915	28.113	25.949	0.2	0.8	1.1	3.6	29.8	29.5	30.0	30.4	7	16	18	16
3	4.0	6.0	8.5	6.0	23.022	26.523	27.865	28.546	2.5	2.1	1.7	3.9	29.2	28.9	29.3	29.3	13	16	12	16
3	4.5	8.0	6.0	6.0	22.541	26.410	28.049	28.402	2.0	1.6	1.3	2.3	29.6	29.6	29.6	29.9	13	16	15	15
4	4.5	6.5	8.0	8.0	23.712	27.183	27.971	28.933	1.8	1.2	2.1	4.4	29.1	29.2	29.3	29.2	13	14	15	10
4	4.0	10.0	6.5	6.5	23.573	26.406	28.628	28.947	1.5	1.1	1.6	4.3	29.4	29.5	29.5	29.7	13	18	15	14
5	4.5	9.0	8.0	10.0	25.634	27.558	28.364	29.332	2.5	1.0	1.2	2.2	29.6	29.3	29.5	29.4	14	17	20	15
5	4.0	10.0	5.5	6.0	25.557	27.700	27.817	28.569	2.2	1.3	1.9	8.7	29.3	29.5	29.5	29.6	14	19	12	16
6	4.0	11.0	6.5	12.0	26.068	28.208	28.316	28.514	2.6	1.3	1.7	1.0	29.3	29.3	29.5	29.2	15	20	10	18

FIELD PROCEDURES

1.0 SAMPLE STATIONS

Field and Laboratory measurements listed were made at twenty-four different stations during the mission on July 24, 1972.

The area of the experiment was divided into four sub-areas (A, B, C, & D). One measurement boat was assigned to each sub-area. Each sub-area contained six sample stations spaced approximately two miles apart. All boats were on their first station at 0800 CDT the day of the mission and then commenced taking data.

The boats proceeded in a serial fashion from their first station until all the stations in his area had been sampled. The boats then proceeded back to their starting stations, stopping at each intervening sampling station.

The time required for a boat to stop at a station, take its surface measurement, and travel to the next station was approximately twenty-five minutes.

FIELD PROCEDURES

2.0 SURFACE MEASUREMENT METHODS

2.1 Water Temperature

Surface water temperature measurements were made by taking a bucket sample of water and immediately immersing a mercury bulb thermometer in the center of the bucket.

2.2 Air Temperature

Air temperature measurements were taken with mercury bulb thermometers as near the water surface as possible on the shady side of the boat.

2.3 Relative Humidity

Relative humidity values were obtained with sling psychrometers.

2.4 Water Transparency (Secchi Disc)

Water transparency was determined with a 12-inch secchi disc.

2.5 Water Samples

A one pint water sample was taken at each station for laboratory analysis.

2.6 Meteorological Data

Meteorological data was taken at MTF as an aid in reduction of the remotely sensed data. This includes radiosonde data, surface and meteorological observation. See Figure 1 and Table 1.

3.0 LABORATORY PROCEDURES

Water samples were taken in pint polypropylene bottles for chlorophyll and salinity analysis. Numbers were marked and engraved on the bottles for identification. Plastic buckets (2 1/2 gallons) were used in collecting surface samples. All samples were kept cool and dark in styrofoam ice chests and delivered to the Mississippi Test Facility. Those requiring refrigeration were refrigerated until time of analysis.

3.1 Salinity

Salinities were run with a Beckman Model RS-7B Induction Salinometer. Standard (35⁰/oo) sea water was used as a reference, and salinities were determined from the conductivity ratio of the sample to that of the standard. Temperature and instrument drift corrections were made according to the Beckman manual.

3.2 Chlorophyll

The technique used for determination of chlorophyll, which gives a measure of the phytoplankton present, was essentially that proposed by SCOR-UNESCO working group 17 in Determination of Phytosynthetic Pigments in Sea Water, UNESCO, Paris 1969.

Each water sample for chlorophyll analysis was filtered through a millipore 0.45 micron acetate filter. The filters and their residue were stored at -15°C over activated silica gel. Each filter and its residue were ground in a teflon tissue grinder. Ninety percent acetone was used as the extracting agent. The acetone homogenates were stored in the dark for ten minutes, then centrifuged at 2000 g for approximately ten minutes. The volume of each extract was recorded and the absorption spectrum of the chlorophyll extract measured against a blank acetate filter dissolved in 90% acetone. The measurements were made on a Cary 17 Spectrophotometer.

The absorption spectra were indexed at 750, 663, 645, and 630 $\text{m}\mu$. The absorption at 663, 645 and 630 $\text{m}\mu$ was corrected by comparison with the absorption of the "reference blank" at 750 $\text{m}\mu$. These corrected values are used in the following formula to determine chlorophyll a.

$$\text{chl } \underline{a} = (11.64 \times e_{663} - 2.16 \times e_{645} + 0.10 \times e_{630}) \times$$

$$\frac{\text{ext (ml)}}{\text{vol (l)}} \times \frac{1}{\text{absorption cell light path (cm)}}$$

where e_{663} = absorption at 663 μ

e_{645} = absorption at 645 $m\mu$

e_{630} = absorption at 630 $m\mu$

ext = extract volume

vol - volume of sample

Abbreviation

chlo A m/m^3

salin pts/K

Name

chlorophyll a milligrams/per cubic meter

salinity \ part per
 \ thousand

FIGURE 1 SKREW T, Log P DIAGRAM
MISSISSIPPI TEST FACILITY RADIOSONDE
24 JULY 1972 1410 GMT

HEIGHT METERS	TEMP DEG C	D PT DEG C	PRESS MBS
0.	27.0	23.7	1017.
220.	24.8	21.5	992.
355.	25.8	19.0	977.
713.	24.3	14.5	938.
1084.	22.0	13.4	899.
1289.	20.2	10.2	878.
1468.	18.9	11.7	860.
2696.	10.9	1.6	744.
3061.	8.6	-3.4	712.
3501.	5.9	-4.7	675.
3833.	3.3	-7.8	648.
4229.	.9	-15.1	617.
4806.	-2.4	-20.6	574.
5045.	-2.1	-22.6	557.
5409.	-3.7	-24.3	532.
6310.	-9.7	-29.9	474.
6932.	-14.4	-20.7	437.
7214.	-15.5	-23.9	421.
8442.	-22.6	-37.5	357.
8525.	-23.6	-40.7	353.
9235.	-28.7	-41.9	320.
9885.	-33.2	-47.7	292.
11202.	-44.4	-57.3	241.

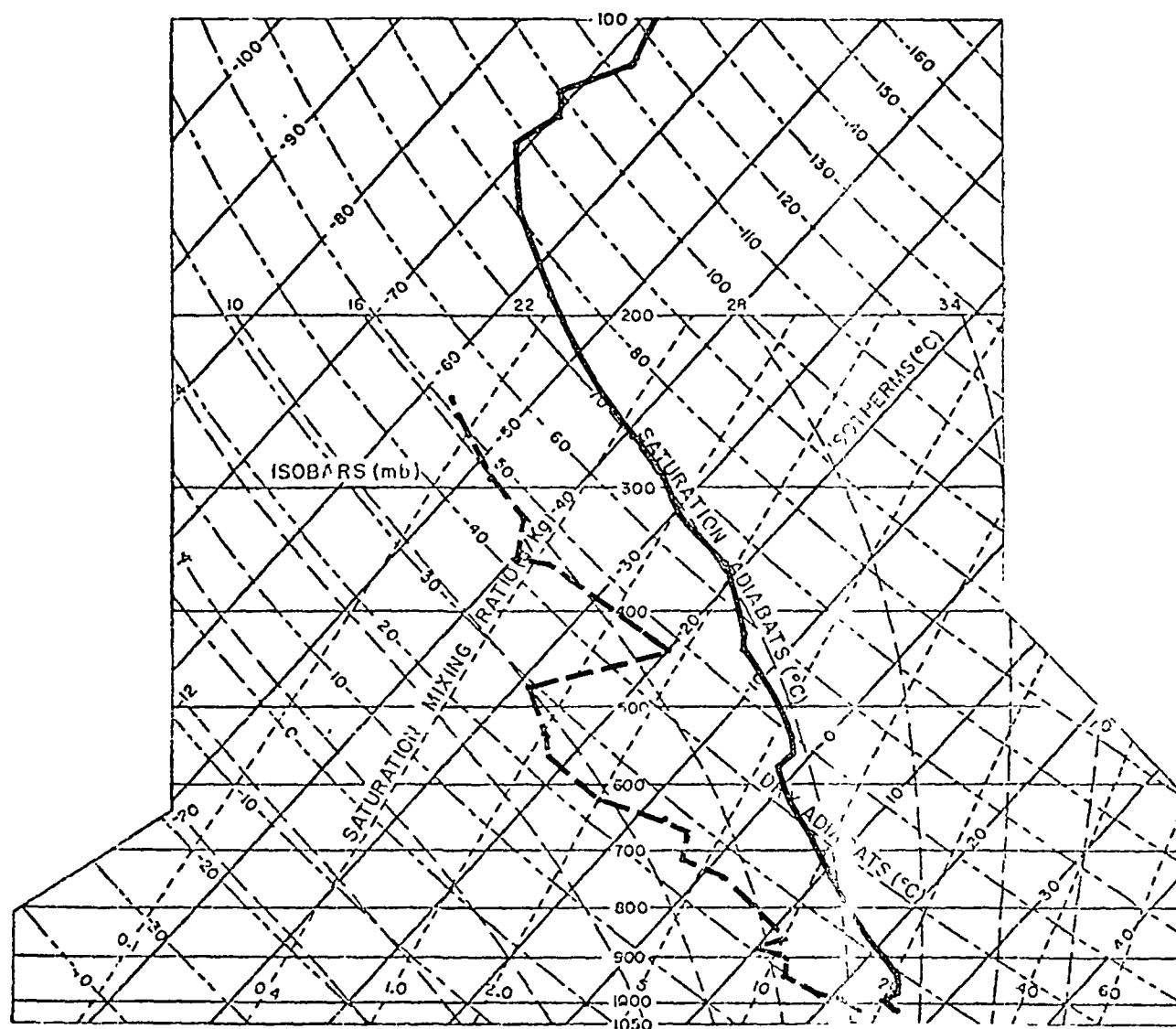


TABLE I
SURFACE WEATHER OBSERVATION
MISSISSIPPI TEST FACILITY
JULY 24, 1972

TIME CDT	SKY AND CEILING	VISIBILITY (ML)	OBSTRUCTION TO VISION	TEMP °C	WIND		PRESSURE (Mb)	DEW POINT	RELATIVE HUMIDITY %
					DIR. (Deg)	SPEED (Kt)			
0900	Clear	5	Smoke Haze	27	270	4	1018.5	75	82
1000	Clear	5	Smoke Haze	29	260	5	1018.1	74	71
1100	Clear	5	Smoke Haze	31	265	7	1018.2	72	60
1200	Scat'd 4K Ft.	6	Smoke Haze	32	285	3	1018.2	72	57
1300	Scat'd 4K Ft.	6	Smoke Haze	33	270	4	1017.5	72	53
1400	Scat'd 4K Ft.	6	Smoke Haze	34	175	4	1016.9	71	48

48 HOUR PRECIPITATION JULY 22, 1972 THROUGH JULY 24, 1972

0.00

TABLE II
MISSISSIPPI SOUND STATION LOCATIONS

<u>Station No.</u>	<u>Latitude</u>	<u>Longitude</u>	<u>Station No.</u>	<u>Longitude</u>	<u>Latitude</u>
A1	30°16'35"N	89°17'15"W	C1	30°16'31"N	88°48'00"W
A2	30°16'35"N	89°14'45"W	C2	30°16'31"N	88°45'40"W
A3	30°16'35"N	89°12'25"W	C3	30°16'31"N	88°43'20"W
A4	30°16'35"N	89°09'58"W	C4	30°16'31"N	88°40'45"W
A5	30°16'35"N	89°07'30"W	C5	30°16'31"N	88°38'28"W
A6	30°16'35"N	89°05'00"W	C6	30°16'31"N	88°35'59"W
B1	30°16'34"N	89°02'35"W	D1	30°16'30"N	88°33'30"W
B2	30°16'34"N	89°00'15"W	D2	30°16'30"N	88°31'15"W
B3	30°16'34"N	88°57'58"W	D3	30°16'30"N	88°28'45"W
B4	30°16'34"N	88°55'30"W	D4	30°16'30"N	88°26'20"W
B5	30°16'34"N	88°53'00"W	D5	30°16'30"N	88°24'00"W
B6	30°16'34"N	88°50'30"W	D6	30°16'30"N	88°21'30"W

NOTE: It is estimated that the surface measurements were made within a quarter mile of the above station locations.

TABLE III
MISSISSIPPI SOUND
SURFACE DATA AND LABORATORY MEASUREMENTS

<u>Station Number</u>	<u>Time CDT</u>	<u>Water Temp Deg C</u>	<u>Air Temp Deg C</u>	<u>Relative Humidity Percent</u>	<u>Secchi Visibility Feet</u>	<u>Water Depth Feet</u>	<u>Sea State Feet</u>	<u>Wind Dir. Deg.</u>	<u>Wind Speed Kt.</u>	<u>Salin Pts/K</u>	<u>Chlo A m/m³</u>
A1	0855	28.8	29.0	74	3.5	6.0	1.0	270	8	22.104	2.9
A1	1200	30.2	32.4	68	4.0	7.0	1.0	270	8	22.282	1.5
A2	0920	29.0	29.0	79	4.5	7.0	1.5	270	8	21.962	2.5
A2	1140	29.8	32.6	74	4.0	7.0	1.0	270	8	21.701	0.2
A3	0940	29.2	29.8	80	4.0	13.0	1.5	270	8	23.022	2.5
A3	1122	29.6	31.8	71	4.5	13.0	1.0	270	8	22.541	2.0
A4	1000	29.1	30.6	77	4.5	13.0	1.0	270	8	23.772	1.8
A4	1108	29.4	31.8	71	4.0	13.0	1.0	270	8	23.573	1.5
A5	1022	29.6	28.8	77	4.5	14.0	1.0	270	8	25.634	2.5
A5	1050	29.3	31.4	74	4.0	14.0	1.0	270	8	25.557	2.2
A6	1035	29.3	29.5	77	4.0	15.0	1.0	270	8	26.068	2.6
B1	0800	28.4	28.0	91	4.0	16.0	2.0	240	10	27.582	3.0
B1	1210	29.5	29.5	79	6.0	16.0	1.5	240	10	28.682	2.1

TABLE III
MISSISSIPPI SOUND
SURFACE DATA AND LABORATORY MEASUREMENTS (Cont'd)

<u>Station Number</u>	<u>Time CDT</u>	<u>Water Temp Deg C</u>	<u>Air Temp Deg C</u>	<u>Relative Humidity Percent</u>	<u>Secchi Visibility Feet</u>	<u>Water Depth Feet</u>	<u>Sea State Feet</u>	<u>Wind Dir. Deg.</u>	<u>Wind Speed Kts.</u>	<u>Salin Pts/K</u>	<u>Chlo A m/m³</u>
B2	0825	28.3	27.7	87	6.0	16.0	1.5	240	10	27.136	No data
B2	1145	29.5	29.5	78	6.5	16.0	1.5	240	10	26.915	0.8
B3	0844	28.9	27.4	85	6.0	16.0	1.5	240	10	26.523	2.1
B3	1120	29.6	28.8	85	8.0	16.0	1.5	240	10	26.410	1.6
B4	0910	29.2	27.8	88	6.5	14.0	1.5	240	12	27.183	1.2
B4	1055	29.5	28.7	82	10.0	18.0	1.5	240	8	26.406	1.1
B5	0933	29.3	30.6	82	9.0	17.0	1.5	240	10	27.558	1.0
B5	1030	29.5	28.4	79	10.0	19.0	1.5	240	8	27.700	1.3
B6	1005	29.3	29.5	86	11.0	20.0	1.5	240	8	28.208	1.3
C1	0800	28.9	28.1	81	10.0	15.0	0.8	300	10	27.462	1.0
C1	1240	30.5	31.4	71	8.0	15.0	0.6	220	10	27.977	2.9
C2	0825	29.0	29.0	73	8.0	13.0	1.0	305	12	27.738	1.6
C2	1145	30.0	32.1	65	8.0	18.0	0.6	280	10	28.113	1.1

TABLE III

MISSISSIPPI SOUND

SURFACE DATA AND LABORATORY MEASUREMENTS (Cont'd)

Station Number	Time CDT	Water Temp <u>Deg C</u>	Air Temp <u>Deg C</u>	Relative Humidity <u>Percent</u>	Secchi Visibility <u>Feet</u>	Water Depth <u>Feet</u>	Sea State <u>Feet</u>	Wind Dir. <u>Deg.</u>	Wind Speed <u>Kts.</u>	Salin Pts/K	Chlo A ₃ <u>m/m³</u>
C3	0850	29.3	29.9	71	8.5	12.0	1.0	310	12	27.865	1.7
C3	1120	29.6	32.3	68	6.0	15.0	0.6	240	10	28.049	1.3
C4	0915	29.3	29.5	74	8.0	15.0	0.8	250	10	27.971	2.1
C4	1055	29.5	30.4	78	6.5	15.0	0.6	240	10	28.628	1.6
C5	0940	29.5	29.7	77	8.0	20.0	0.8	270	10	28.364	1.2
C5	1030	29.5	29.7	77	5.5	12.0	0.6	240	10	27.817	1.9
C6	1005	29.5	29.6	74	6.5	10.0	0.6	250	10	28.316	1.7
D1	0820	29.0	28.5	81	4.0	14.0	0.5	315	10	26.476	3.9
D1	1210	30.5	29.9	71	6.5	12.0	0.5	315	10	26.237	3.2
D2	0840	29.0	28.2	77	6.0	15.0	0.5	315	10	28.487	1.7
D2	1145	30.4	30.1	71	6.0	16.0	0.5	315	10	25.949	3.6
D3	0900	29.3	29.0	77	6.0	16.0	0.5	315	10	28.546	3.9
D3	1120	29.9	31.0	71	6.0	15.0	0.5	315	10	28.402	2.3

TABLE III
MISSISSIPPI SOUND
SURFACE DATA AND LABORATORY MEASUREMENTS (Cont'd)

<u>Station Number</u>	<u>Time CDT</u>	<u>Water Temp Deg C</u>	<u>Air Temp Deg C</u>	<u>Relative Humidity Percent</u>	<u>Secchi Visibility Feet</u>	<u>Water Depth Feet</u>	<u>Sea State Feet</u>	<u>Wind Dir. Deg.</u>	<u>Wind Speed Kts.</u>	<u>Salin Pts/K</u>	<u>Chlo A m/m³</u>
D4	0915	29.2	29.0	81	8.0	10.0	0.5	315	10	28.933	4.4
D4	1055	29.7	32.5	75	6.5	14.0	0.5	315	10	28.947	4.3
D5	0940	29.4	30.1	81	10.0	15.0	0.5	315	10	29.332	2.2
D5	1035	29.6	31.0	77	6.0	16.0	0.5	315	10	28.569	8.7
D6	1005	29.2	30.2	74	12.0	18.0	0.5	315	10	28.514	1.0

TABLE IV
GSFC/CV-990 FLIGHT TIMES

APPROXIMATE CDT

FLIGHT LINE

Start Stop

8:57 9:04

West to East high altitude flight line (37K ft.)

9:09 9:16

East to West high altitude flight line (35K ft.)

9:32 9:44

West to East low altitude flight line (1K ft.)

9:48 9:59

East to West low altitude flight line (1K ft.)

FLIGHT LINE START AND STOP COORDINATES

Start 30°16'40"N, 89°19'35"W

Stop 30°16'33"N, 88°20'00"W

WATER MEASUREMENTS SUPPORT FOR GODDARD SPACE FLIGHT CENTER
SPECTROMETER WATER COLOR STUDY
MISSISSIPPI SOUND AREA
24 JULY 1972

